



ACCREDITED TESTING LABORATORY (NR. 312)
for Electromagnetic Compatibility
FCC Recognition as accredited EMC Test Laboratory No: 835627

TEST REPORT No. EMV-E 45/22

Test procedure: Title 47 - Telecommunication
Chapter I - FEDERAL COMMUNICATIONS COMMISSION
Subchapter A - GENERAL
Part 15 - RADIO FREQUENCY DEVICES

The summary of the results can be found on page 2.

Ordered by: TTTech Computertechnik AG

Address: Schönbrunner Strasse 7
1040 Wien
Austria

On: DUT1: TTC2385
DUT2: TTC2390
DUT3: TTC2380
DUT4: TTC2310

FCC-ID: 2AUIVTTC2300

This report contains the pages 1 to 29.

Authorized person:

Test performed by:

Ing. Thomas Nakovits

Ing. Michael Szobel

Date: 2022-06-13
Internal Order Number: EMC/E-3074_1 - EMC/E-3074_4

Comments:

The test results refers exclusively to the tested subject.

The production or transmission of extracts of the present report is subject to authorization by the testing laboratory.

Akkreditierung Austria is a full member of the International Laboratory Accreditation Cooperation ILAC and a signatory of the MRA for "Testing, Calibration and Inspection".

1. Summary of all measurements and tests

Measurements according to FCC 47 CFR Part 15 Subpart B - Unintentional Radiators			
Chapter / Norm. Reference	Term	Details see chapter	Result
§15.107 ANSI C63.4-2014	Conducted limits - (AC power line)	---	n.a. ^a
§15.109 ANSI C63.4-2014	Radiated emission limits	4.1	PASS

Table 1: Summary Emission measurements

PASS	The DUT meets the requirements of the standard
FAIL	The DUT does not meet the requirements of the standard
n.a.	The Test is not applicable
n.p.	The Test was not performed

Table 2: General definitions for the report

All indications of Pass/Fail in this report are opinions expressed by Seibersdorf Laboratories based on interpretations and/or observations of test results.

^a not applicable: device under test has no AC power supply

2. Contents

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3. General information

3.1 Device under test (DUT)

DUT1: TTC2385
TTTech DUT number: DUT17
Version number: 00.07-A
Serial number: 06220840000023
Software version: 193
Product number: [14069]

DUT2: TTC2390
TTTech DUT number: DUT20
Version number: 00.07-D
Serial number: 06220850000059
Software version: 193
Product number: [14070]

DUT3: TTC2380
TTTech DUT number: DUT19
Version number: 00.07-C
Serial number: 06220850000019
Software version: 193
Product number: [14068]

DUT4: TTC2310
TTTech DUT number: DUT18
Version number: 00.07-B
Serial number: 06220840000065
Software version: 193
Product number: [14067]

FCC-ID: 2AUIVTTC2300
Year of manufacturing: 2022/03

Manufacturer: **TTTech Computertechnik AG**
Address: Schönbrunner Strasse 7
1040 Wien
Austria

Description: The TTC 2000 series is a generic ECU family which can be used for different applications where sensor values must be captured and evaluated. Furthermore hydraulic and electric actuators can be controlled with several high-side or low-side outputs. The interaction with other ECUs in the overall system is done via different communication interfaces like 100Base-T1 (BroadR-Reach), CAN or LIN.



Photo 1: Device under test TTC2385, Label



Photo 2: Device under test TTC2390, Label



Photo 3: Device under test TTC2380, Label



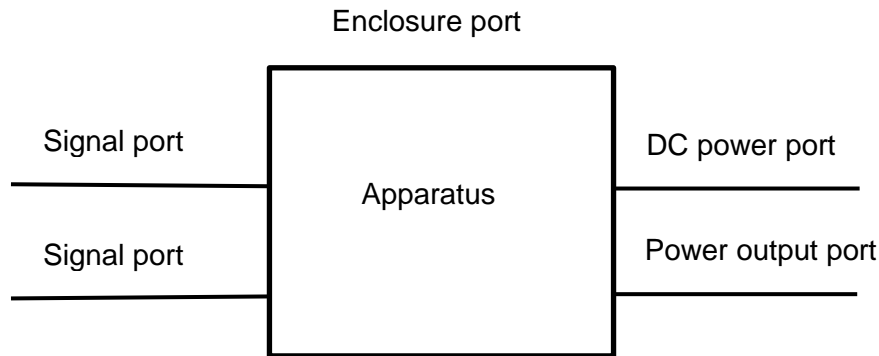
Photo 4: Device under test TTC2310, Label

The device under test and all relevant information regarding the device under test were supplied by the customer.

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3.2 Test Configuration

The DUT was mounted by Mr. Till, TTTech Computertechnik AG and Mr. Szobel, Seibersdorf Labor GmbH, in the anechoic chamber of the EMC-Test Laboratory Seibersdorf.



Type	Name	Cable type	Cable length
DC power port	GND	6 wires x 2.0mm ² not shielded	1.8m
DC power port	BAT+POWER	6 wires x 2.0mm ² not shielded	1.8m
DC power port	BAT+CPU	1 wire x 2.0mm ² not shielded	1.8m
Power output port	HS_00-15	16 wires x 0.75mm ² not shielded	1.8m
Power output port	HS_16-17	2 wires x 2.0mm ² not shielded	1.8m
Power output port	HS_18-27	10 wires x 0.75mm ² not shielded	1.8m
Power output port	LS_00-11	12 wires x 0.75mm ² not shielded	1.8m
Signal port	TS_00-03	4 wires x 0.75mm ² not shielded	1.8m
Signal port	TCL_00-07	8 wires x 0.75mm ² not shielded	1.8m
Signal port	AD3_00-07	8 wires x 0.75mm ² not shielded	1.8m
Power output port	SSUP_0-2	3 wires x 0.75mm ² not shielded	1.8m
Power output port	SNS_GND	4 wires x 0.75mm ² not shielded	1.8m
Signal port	EMS	3 wires x 0.75mm ² not shielded	1.8m
Signal port	T15	1 wire x 0.75mm ² not shielded	1.8m
Signal port	WAKE_UP	1 wire x 0.75mm ² not shielded	1.8m
Signal port	LIN	1 wire x 0.75mm ² not shielded	1.8m
Signal port	CAN	5 twisted pairs 0.5mm ² not shielded	1.8m

Table 3: Cable configuration

Operation Mode for emissions measurements and immunity test:

- "Standard use", which is the field use case of the device as intended by an operator.

3.3 Standards / Documents

- [1] **Code of Federal Regulations**
Title 47 - Telecommunication
Chapter I - FEDERAL COMMUNICATIONS COMMISSION
Subchapter A - GENERAL
Part 15 - RADIO FREQUENCY DEVICES
- [2] **ANSI C63.4-2014**
American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
- [3] **CISPR 16-1-1:2010-11**
Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods - Part 1-1: Radio Disturbance and Immunity Measuring Apparatus - Measuring Apparatus, Ed. 3.1
- [4] **CISPR 16-1-2:2006-08**
Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods - Part 1-2: Radio Disturbance and Immunity Measuring Apparatus - Ancillary equipment - Conducted disturbances, Ed. 1.2
- [5] **CISPR 16-1-4:2010-04**
Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods - Part 1-4: Radio Disturbance and Immunity Measuring Apparatus - Ancillary equipment - Radiated disturbances, Ed. 3
- [6] **CISPR 16-2-1:2008 + A1:2010 + A2:2013**
Specification for radio disturbance and immunity measuring apparatus and methods Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements
- [7] **CISPR 16-2-3:2010 + A1:2010 + A2:2014**
Specification for radio disturbance and immunity measuring apparatus and methods Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements

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3.4 Date and location of the measurements and tests

Date: 30 March – 13 April 2022
Location: Semi anechoic chamber (SAC3)
EMC-Test Laboratory
2444 Seibersdorf
Austria

Temperature: 21°C – 25°C
Humidity: 35% - 50 % rel.

4. Measurements and tests – parameters and results

All indications of Pass/Fail in this report are opinions expressed by Seibersdorf Laboratories based on interpretations and/or observations of test results.

4.1 Radiated emissions measurement

4.1.1 Equipment

30 to 1000 MHz:

ID-No.	Identification	Type	SNo	Calibration Date	Calibration Interval	Manufacturer
E0903	EMC Measurement Software EMC32	V 10.60.20	100044/100392	---	---	Rohde & Schwarz
E1142	Thermo-Hygrometer SAC	608-H1	34803704	04 Jul. 2019	3 years	testo
LE0056	EMI Test Receiver	ESW8	100948	02 Nov. 2020	2 years	Rohde & Schwarz
LE0116	Semi Anechoic Chamber with Control Room, Test room 1 and Amplifier Room	SAC3+CR, TR1, AR	P28090	26 Jan. 2018	5 years	Albatross Projects
LE0373	TRILOG Broadband antenna	VULB 9162	489	16 Feb. 2022	1 year	Schwarzbeck

Table 4: Equipment

1000 to 6000 MHz:

ID-No.	Identification	Type	SNo	Calibration Date	Calibration Interval	Manufacturer
E0567	Antenna (DRG Horn)	3115	9808-5569	17 Feb. 2022	2 years	EMCO
E0903	EMC Measurement Software EMC32	V 10.60.20	100044/100392	---	---	Rohde & Schwarz
E1142	Thermo-Hygrometer SAC	608-H1	34803704	04 Jul. 2019	3 years	testo
LE0056	EMI Test Receiver	ESW8	100948	02 Nov. 2020	2 years	Rohde & Schwarz
LE0116	Semi Anechoic Chamber with Control Room, Test room 1 and Amplifier Room	SAC3+CR, TR1, AR	P28090	26 Jan. 2018	5 years	Albatross Projects

Table 5: Equipment

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4.1.2 Procedure and setup

The measurement was done inside the Semi anechoic chamber (SAC3) of the EMC-Test Laboratory Seibersdorf.

Measurement procedure and setup were according to the standard ANSI C63.4.

Frequency range	30 to 1000 MHz
Bandwidth	120 kHz
Step size	40 kHz
Measurement detector	PK / QP
Measurement time	PK: 100 ms, QP: 1 s
Antenna height scan	1 – 4 m
Tilt Antenna	no
Frequency range	1000 to 6000 MHz ^b
Bandwidth	1 MHz
Step size	400 kHz
Measurement detector	AVG
Measurement time	50 ms
Antenna height scan	1 m – 4 m (tilted)
Tilt Antenna	yes
Scan method	Fast Fourier Transformation (FFT)
Maximum hold scans	10
Measurement distance	3 m
Orientations	0° - 360°

Table 6: Parameters

Frequency range [MHz]	Measurement uncertainty [dB]
30 – 200	+4.03 / -4.03
200 – 1000	+3.31 / -3.35
1000 – 18000	+4.59 / -4.75

Table 7: Extended measurement uncertainty

^b The highest frequency generated or used in the device is between 108 MHz and 500 MHz.

According to chapter § 15.33 of the standard the upper frequency of the measurement range is therefore 2000 MHz. According to the customer's request the measurements were performed up to 6000 MHz.

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4.1.3 Results DUT1: TTC2385

Orientation [°]	Polarization	Frequency range [MHz]	Measurement plot	Result
0 - 360	Horizontal	30 - 1000	Chart 1, Table 12	PASS
0 - 360	Vertical	30 - 1000	Chart 2, Table 13	PASS
0 - 360	Horizontal	1000 - 6000	Chart 3, Table 14	PASS
0 - 360	Vertical	1000 - 6000	Chart 4, Table 15	PASS

Table 8: Results

4.1.4 Results DUT2: TTC2390

Orientation [°]	Polarization	Frequency range [MHz]	Measurement plot	Result
0 - 360	Horizontal	30 - 1000	Chart 5, Table 16	PASS
0 - 360	Vertical	30 - 1000	Chart 6, Table 17	PASS
0 - 360	Horizontal	1000 - 6000	Chart 7, Table 18	PASS
0 - 360	Vertical	1000 - 6000	Chart 8, Table 19	PASS

Table 9: Results

4.1.5 Results DUT3: TTC2380

Orientation [°]	Polarization	Frequency range [MHz]	Measurement plot	Result
0 - 360	Horizontal	30 - 1000	Chart 9, Table 20	PASS
0 - 360	Vertical	30 - 1000	Chart 10, Table 21	PASS
0 - 360	Horizontal	1000 - 6000	Chart 11, Table 22	PASS
0 - 360	Vertical	1000 - 6000	Chart 12, Table 23	PASS

Table 10: Results

4.1.6 Results DUT4: TTC2310

Orientation [°]	Polarization	Frequency range [MHz]	Measurement plot	Result
0 - 360	Horizontal	30 - 1000	Chart 13, Table 24	PASS
0 - 360	Vertical	30 - 1000	Chart 14, Table 25	PASS
0 - 360	Horizontal	1000 - 6000	Chart 15, Table 26	PASS
0 - 360	Vertical	1000 - 6000	Chart 16, Table 27	PASS

Table 11: Results

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4.1.7 Photos of the configurations

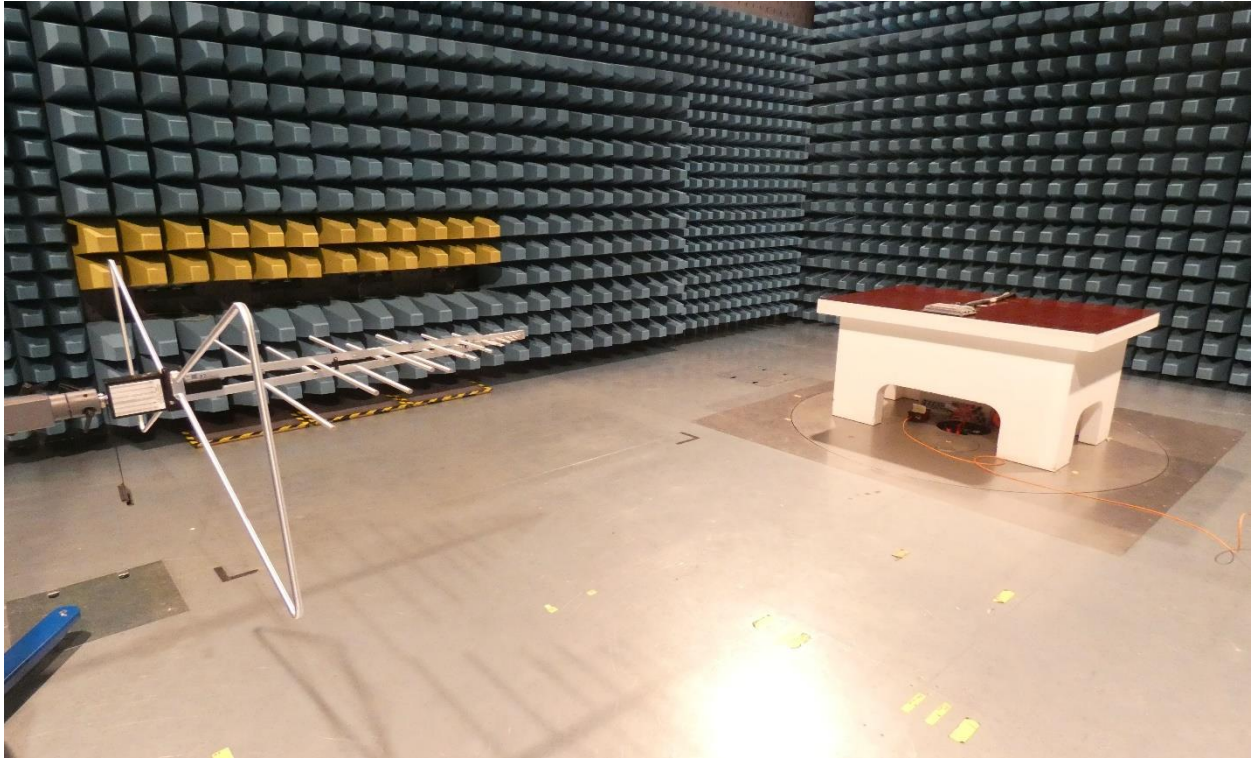


Photo 5: Setup in the semi anechoic chamber from 30 – 1000 MHz

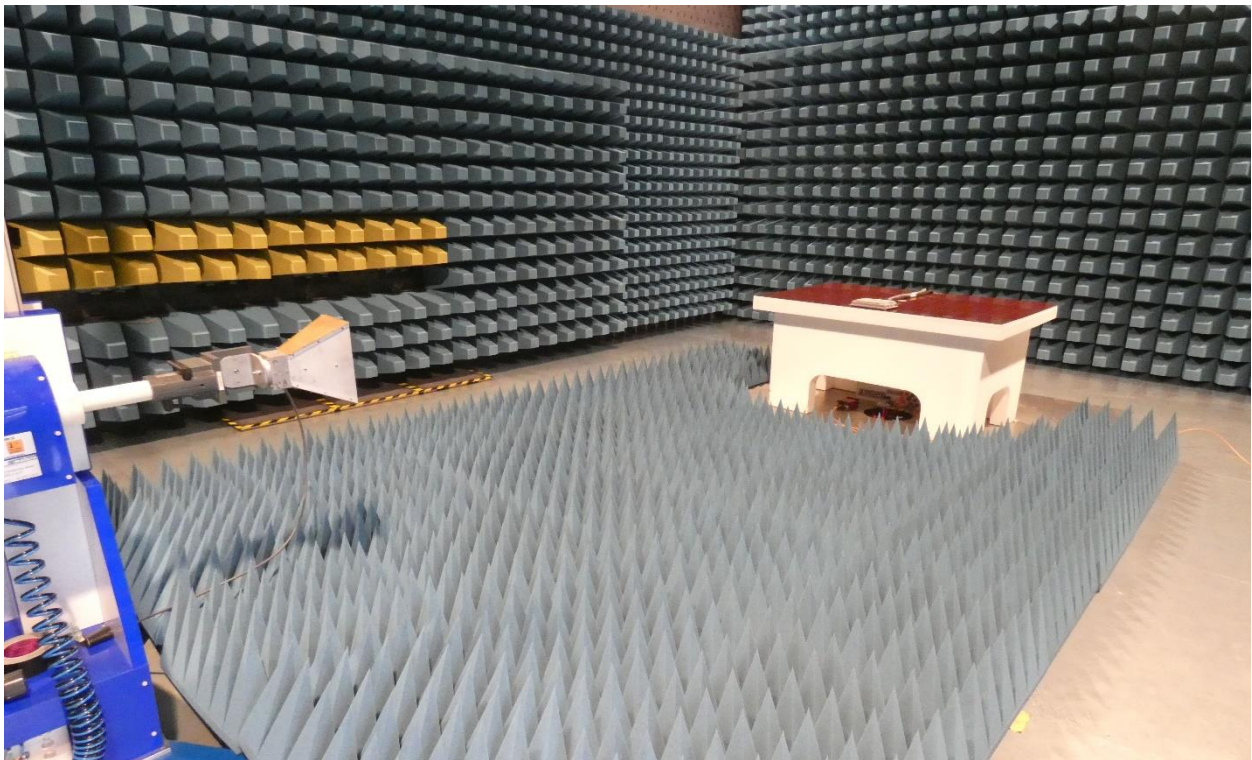
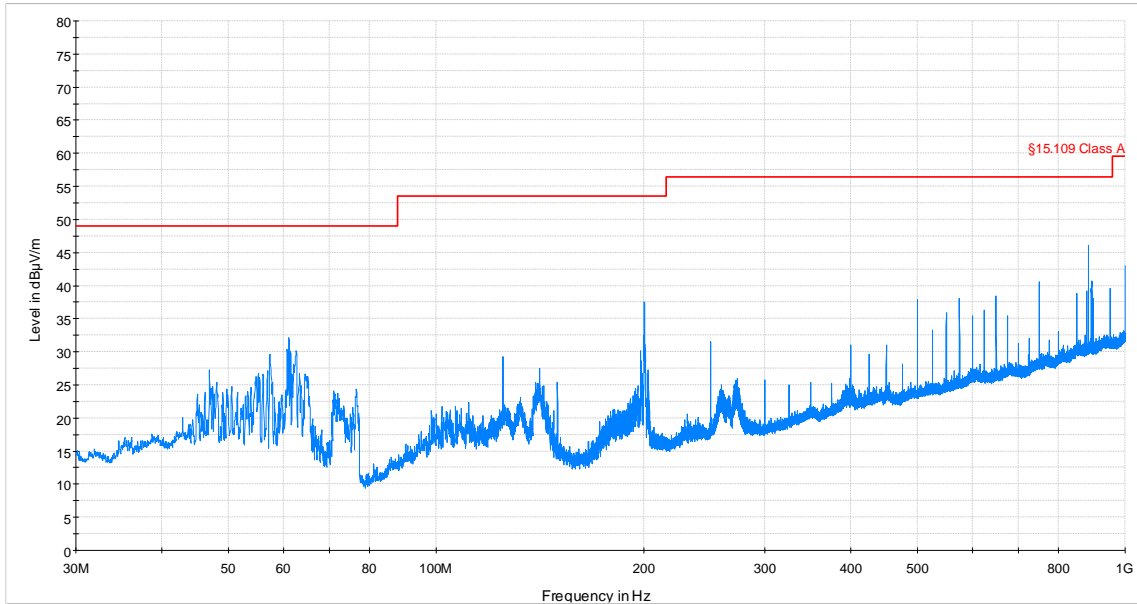


Photo 6: Setup in the semi anechoic chamber from 1000 – 6000 MHz

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4.1.8 Charts DUT1: TTC2385



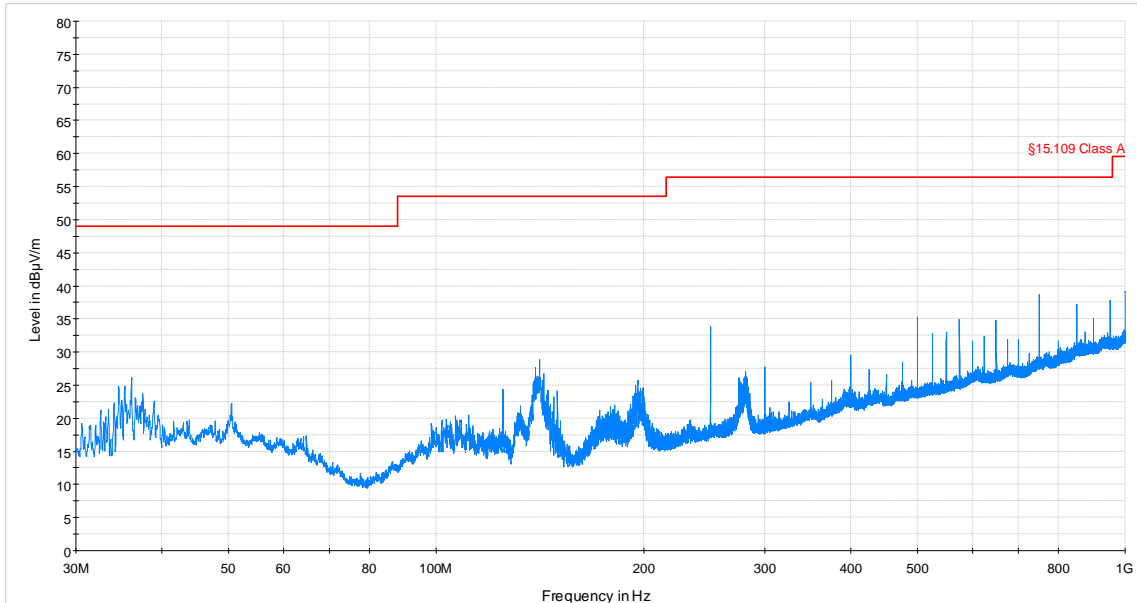
E-3074_1 TTTech 31.03.2022 MS/AJ
TTC2385
Standard use
36 0°-360° 1m-4m H

Preview Result 1H-PK+
§15.109 Class A

Chart 1: Radiated emissions, 30 - 1000 MHz, horizontal

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 12: Quasi-Peak result, 30-1000 MHz, horizontal



E-3074_1 TTTech 31.03.2022 MS/AJ
TTC2385
Standard use
37 0°-360° 1m-4m V

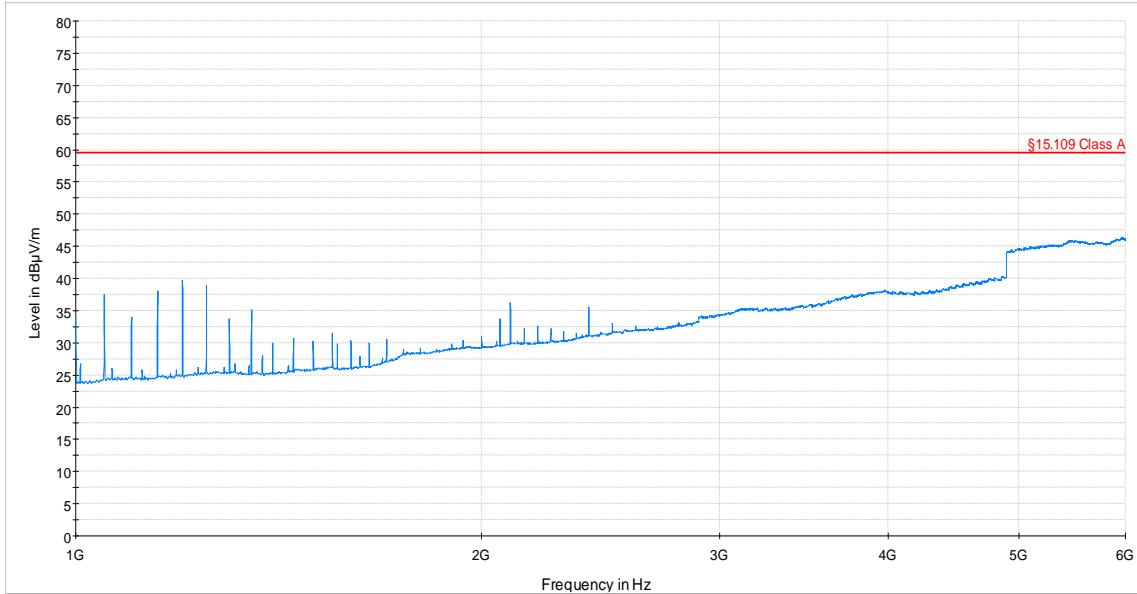
— Preview Result 1V-PK+
— §15.109 Class A

Chart 2: Radiated emissions, 30 - 1000 MHz, vertical

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 13: Quasi-Peak result, 30-1000 MHz, vertical

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E-3074_1 TTTech 05.04.2022 MS/AJ
TTC2385
Standard use
65 0°-360° 1m-4m H

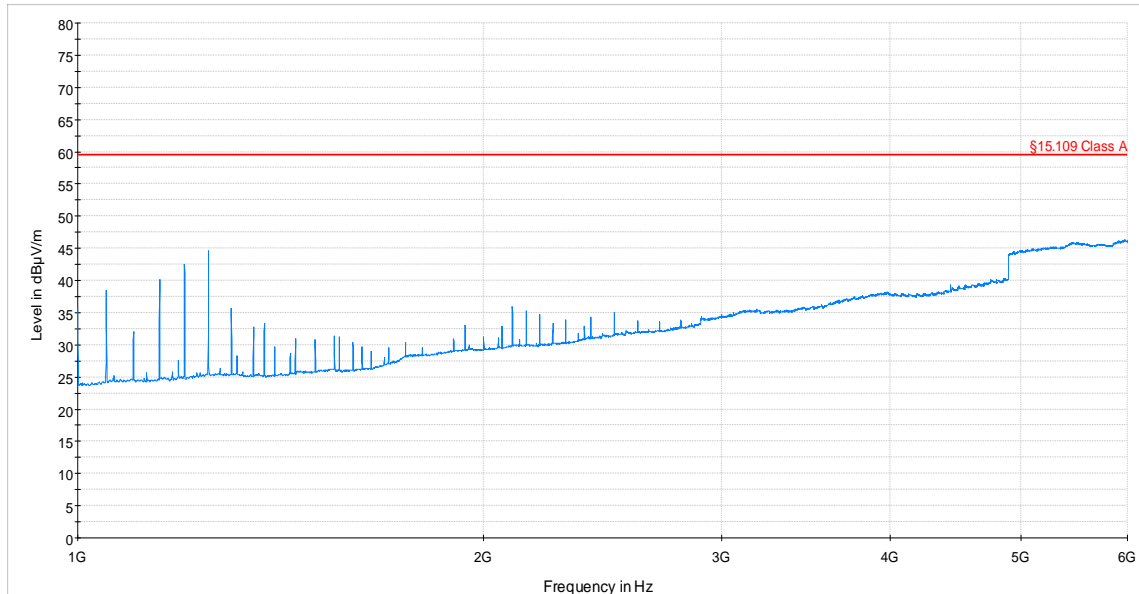
— Preview Result 1-AVG
— §15.109 Class A

Chart 3: Radiated emissions, 1000 - 6000 MHz, horizontal

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 14: Average result, 1000 - 6000 MHz, horizontal

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E-3074_1 TTTech 05.04.2022 MS/AJ
TTC2385
Standard use
64 0°-360° 1m-4m V

— Preview Result 1-AVG
— §15.109 Class A

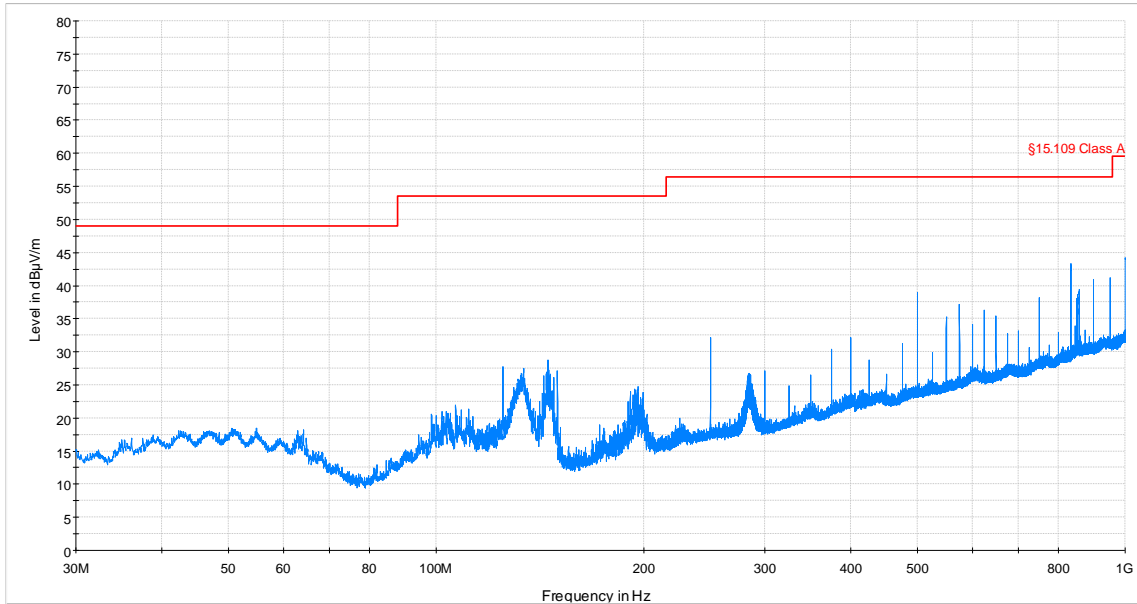
Chart 4: Radiated emissions, 1000 - 6000 MHz, vertical

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 15: Average result, 1000 - 6000 MHz, vertical

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4.1.9 Charts DUT2: TTC2390



E-3074_2 TTTech 31.03.2022 MS/AJ
TTC2390
Standard use
28 0°-360° 1m-4m H

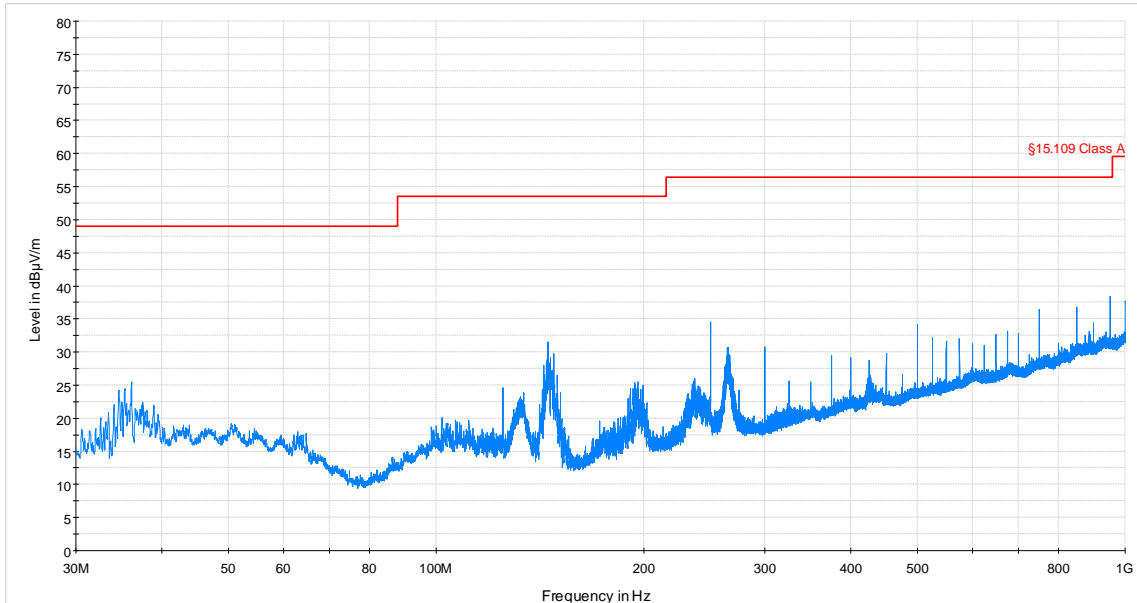
Preview Result 1H-PK+
§15.109 Class A

Chart 5: Radiated emissions, 30 - 1000 MHz, horizontal

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 16: Quasi-Peak result, 30-1000 MHz, horizontal

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E-3074_2 TTTech 31.03.2022 MS/AJ
TTC2390
Standard use
27 0°-360° 1m-4m V

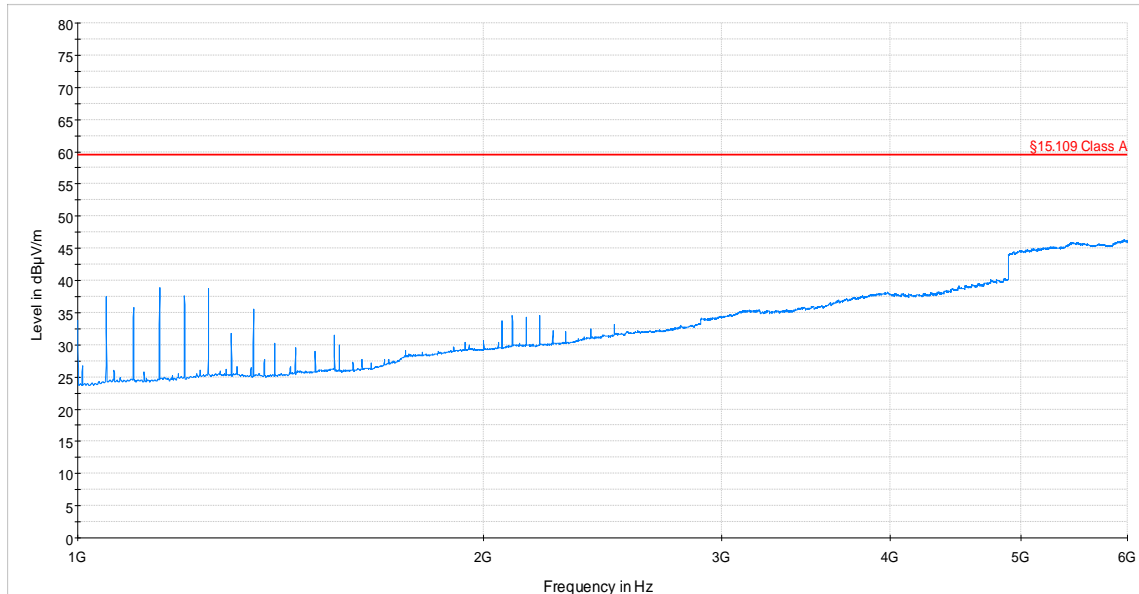
— Preview Result 1V-PK+
— §15.109 Class A

Chart 6: Radiated emissions, 30 - 1000 MHz, vertical

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 17: Quasi-Peak result, 30-1000 MHz, vertical

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E-3074_2 TTTech 05.04.2022 MS/AJ
TTC2390
Standard use
55 0°-360° 1m-4m H

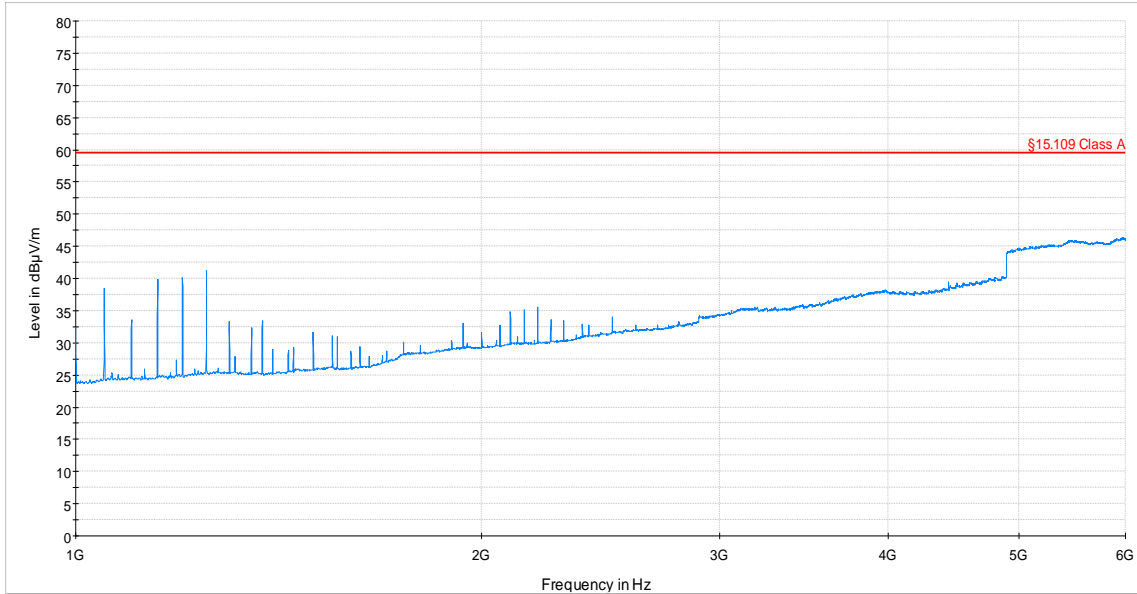
— Preview Result 1-AVG
— §15.109 Class A

Chart 7: Radiated emissions, 1000 - 6000 MHz, horizontal

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 18: Average result, 1000 - 6000 MHz, horizontal

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E-3074_2 TTTech 05.04.2022 MS/AJ
TTC2390
Standard use
56 0°-360° 1m-4m V

— Preview Result 1-AVG
— §15.109 Class A

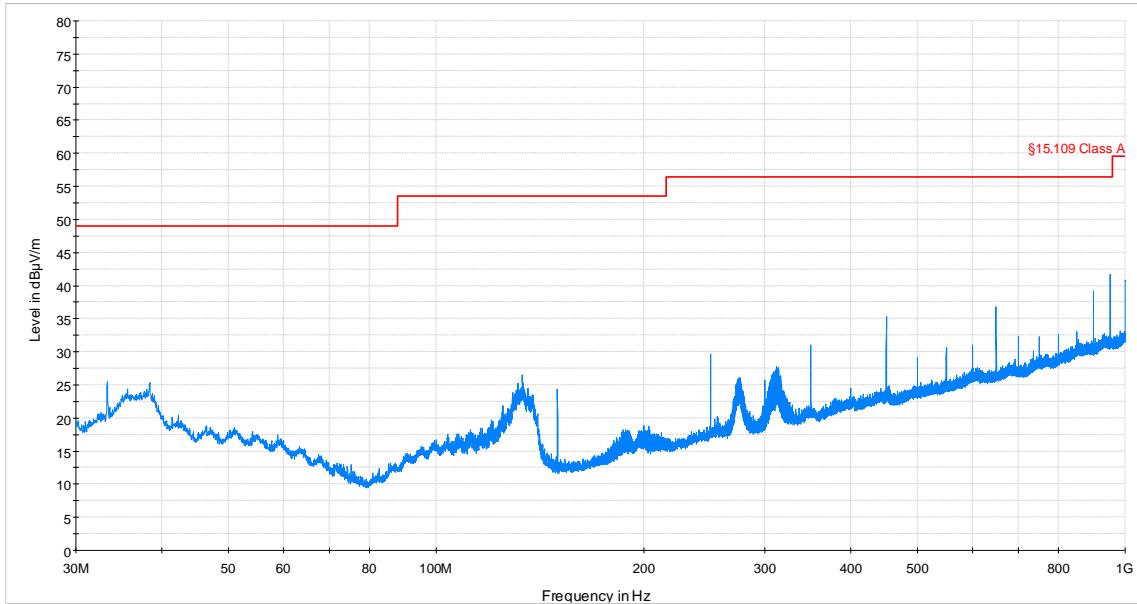
Chart 8: Radiated emissions, 1000 - 6000 MHz, vertical

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 19: Average result, 1000 - 6000 MHz, vertical

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4.1.10 Charts DUT3: TTC2380



E-3074_3 TTTech 31.03.2022 MS/AJ
TTC2380
Standard use
27 0°-360° 1m-4m H

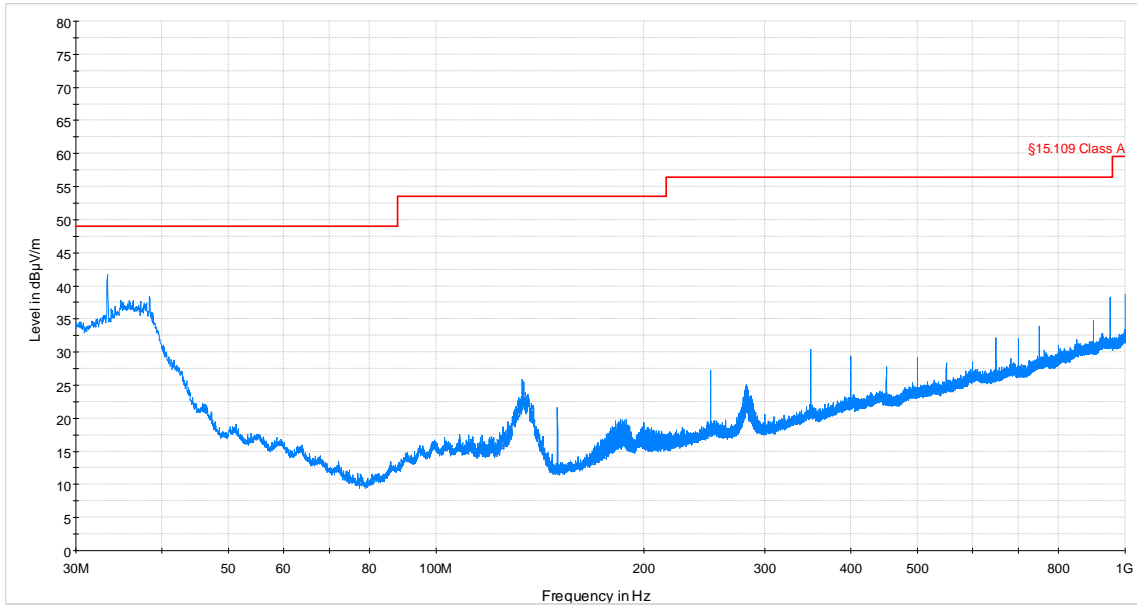
Preview Result 1H-PK+
§15.109 Class A

Chart 9: Radiated emissions, 30 - 1000 MHz, horizontal

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 20: Quasi-Peak result, 30-1000 MHz, horizontal

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E-3074_3 TTTech 31.03.2022 MS/AJ
TTC2380
Standard use
28 0°-360° 1m-4m V

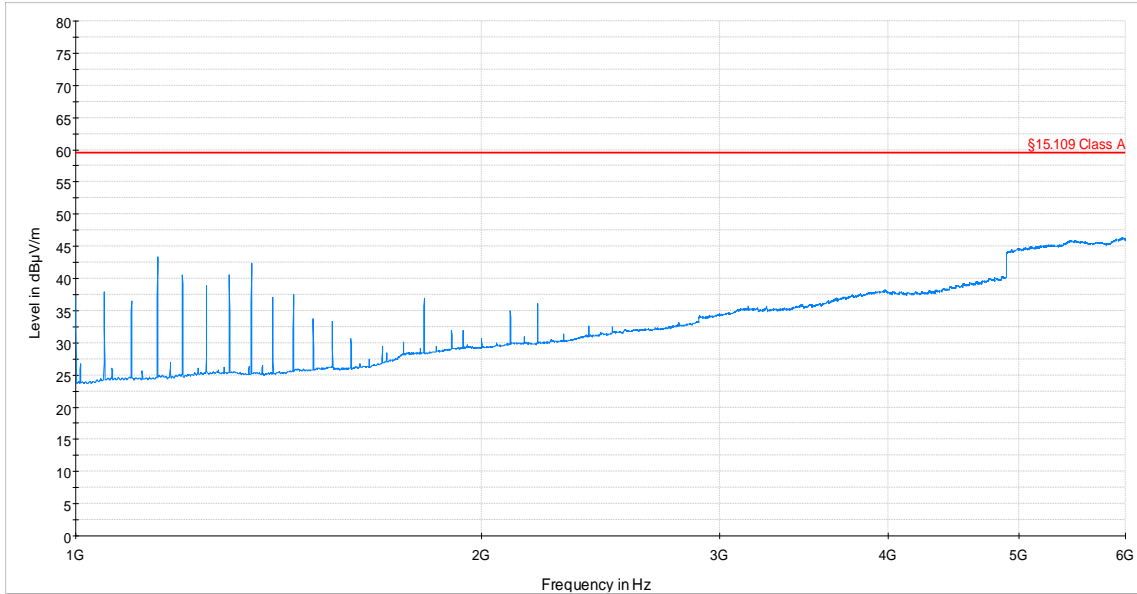
— Preview Result 1V-PK+
— §15.109 Class A

Chart 10: Radiated emissions, 30 - 1000 MHz, vertical

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
33.30	40.40	100.0	120.0	270.0	100.0	7.60	48
33.33	41.70	100.0	120.0	270.0	100.0	6.30	48
33.36	41.30	100.0	120.0	270.0	100.0	6.70	48
33.39	39.50	100.0	120.0	270.0	100.0	8.50	48

Table 21: Quasi-Peak result, 30-1000 MHz, vertical

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E-3074_3 TTTech 05.04.2022 MS/AJ
TTC2380
Standard use
56 0°-360° 1m-4m H

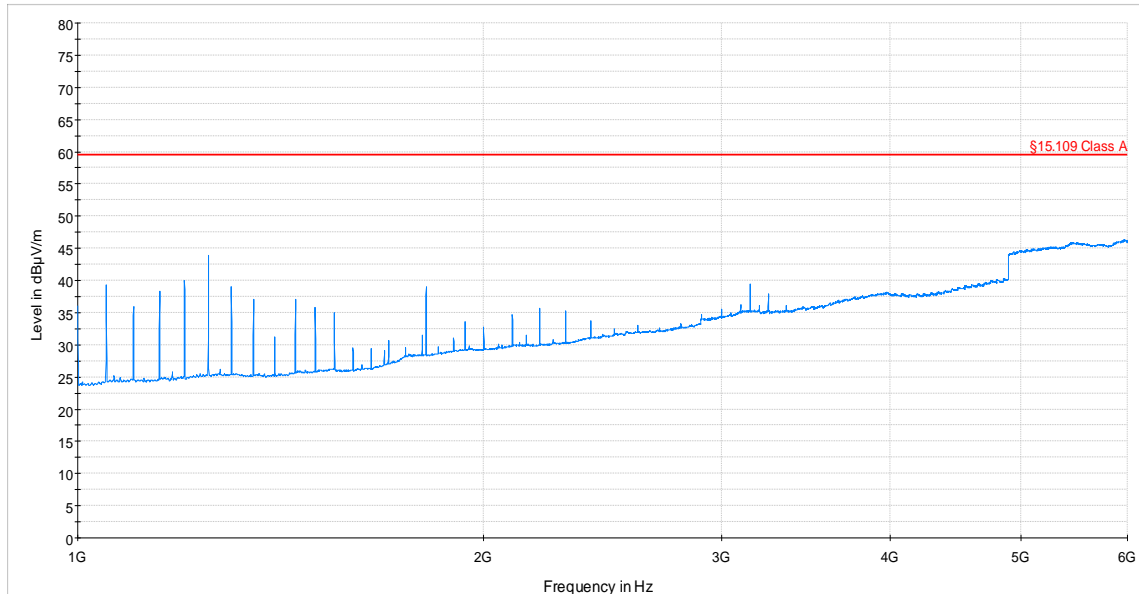
— Preview Result 1-AVG
— §15.109 Class A

Chart 11: Radiated emissions, 1000 - 6000 MHz, horizontal

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 22: Average result, 1000 - 6000 MHz, horizontal

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E-3074_3 TTTech 05.04.2022 MS/AJ
TTC2380
Standard use
55 0°-360° 1m-4m V

— Preview Result 1-AVG
— §15.109 Class A

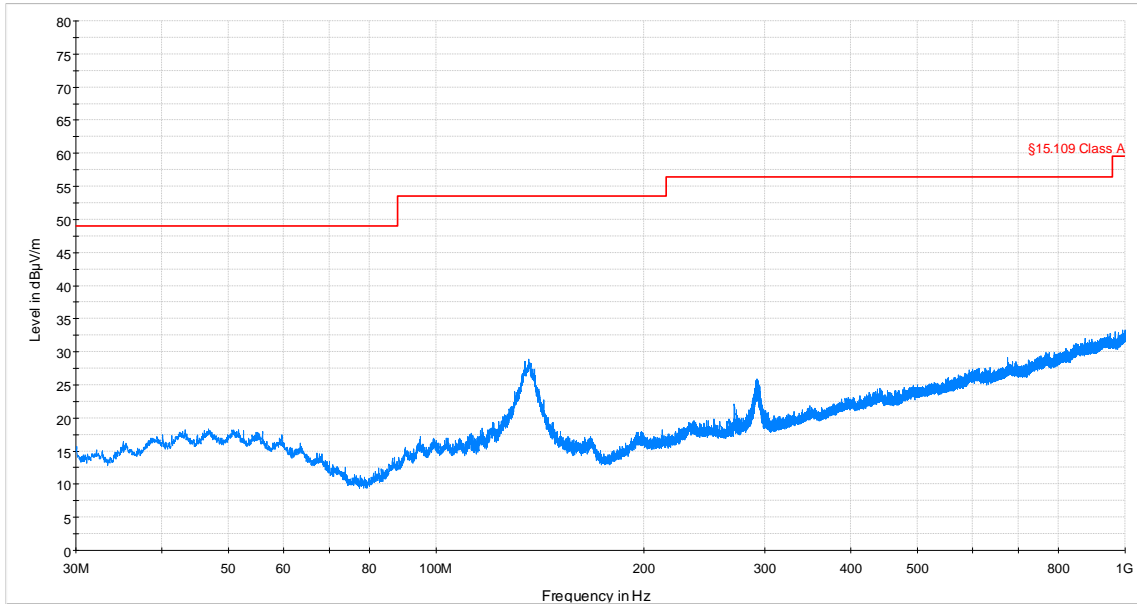
Chart 12: Radiated emissions, 1000 - 6000 MHz, vertical

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 23: Average result, 1000 - 6000 MHz, vertical

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4.1.11 Charts DUT4: TTC2310



E-3074_4 TTTech 31.03.2022 MS/AJ
TTC2310
Standard use
28 0°-360° 1m-4m H

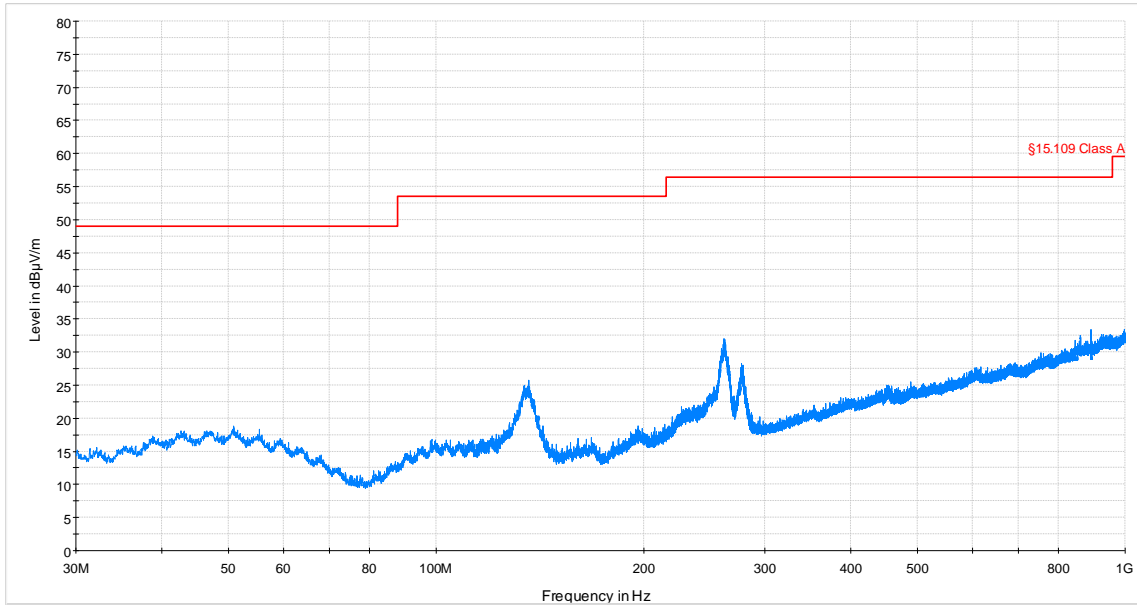
Preview Result 1H-PK+
§15.109 Class A

Chart 13: Radiated emissions, 30 - 1000 MHz, horizontal

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 24: Quasi-Peak result, 30-1000 MHz, horizontal

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E-3074_4 TTTech 31.03.2022 MS/AJ
TTC2310
Standard use
27 0°-360° 1m-4m V

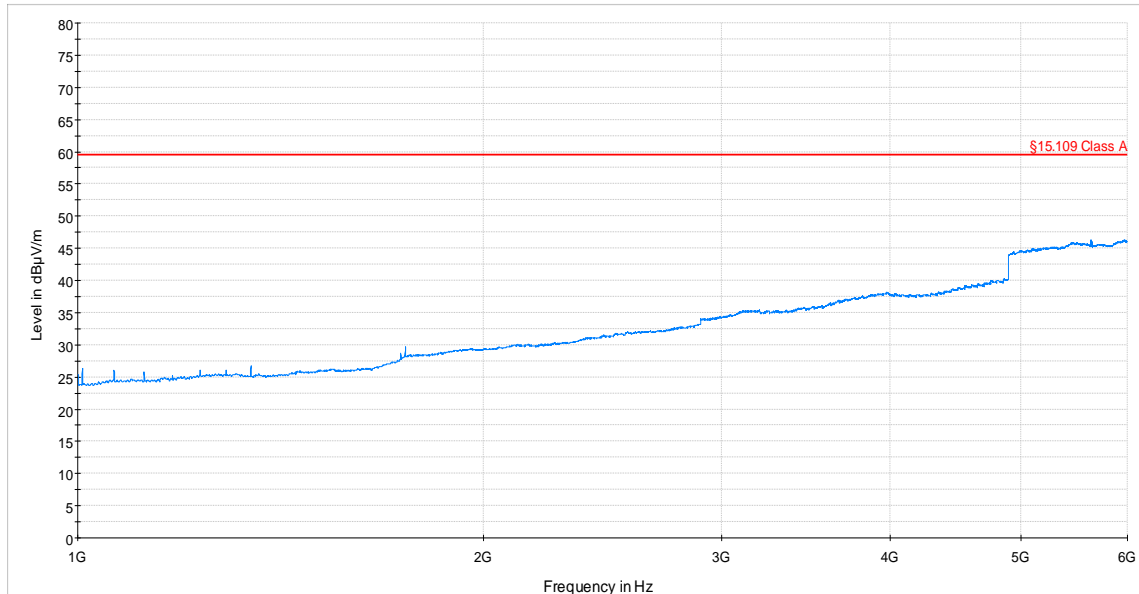
— Preview Result 1V-PK+
— §15.109 Class A

Chart 14: Radiated emissions, 30 - 1000 MHz, vertical

Frequency [MHz]	PK [dBµV/m]	Meas. Time [ms]	Bandwidth [kHz]	Azimuth [deg]	Height [cm]	Margin – PK [dB]	Limit – QPK [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 25: Quasi-Peak result, 30-1000 MHz, vertical

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E-3074_4 TTTech 05.04.2022 MS/AJ
TTC2310
Standard use
55 0°-360° 1m-4m H

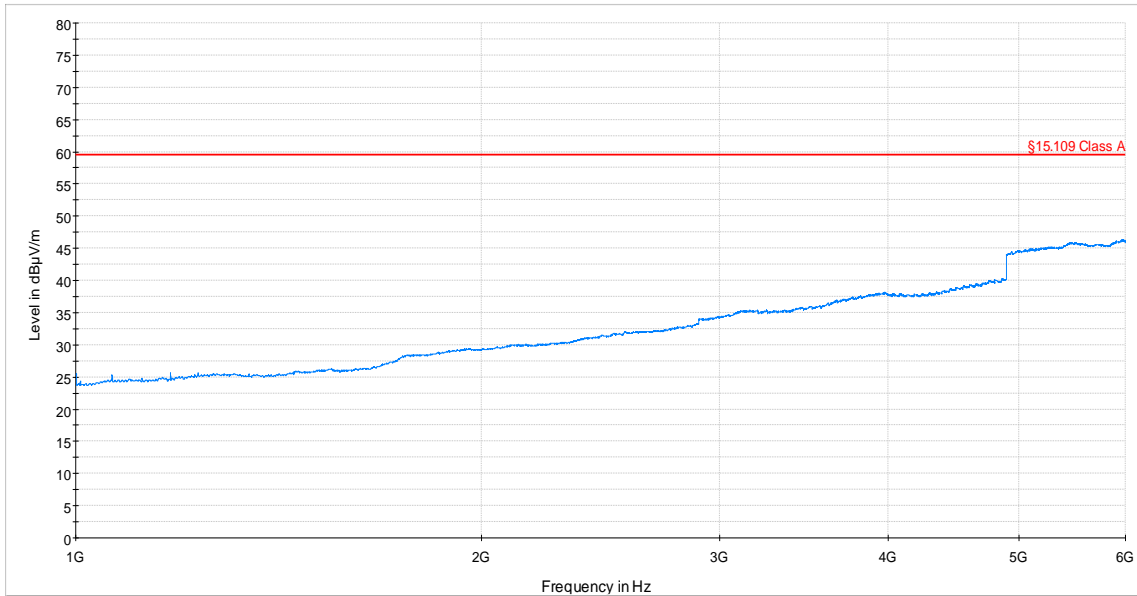
— Preview Result 1-AVG
— §15.109 Class A

Chart 15: Radiated emissions, 1000 - 6000 MHz, horizontal

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 26: Average result, 1000 - 6000 MHz, horizontal

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TTC2310
Standard use
56 0°-360° 1m-4m V

— Preview Result 1-AVG
— §15.109 Class A

Chart 16: Radiated emissions, 1000 - 6000 MHz, vertical

Frequency [MHz]	AVG [dBµV/m]	Meas. Time [ms]	Bandwidth [MHz]	Azimuth [deg]	Height [cm]	Margin – AVG [dB]	Limit – AVG [dBµV/m]
no emissions with margin < 10dB to the limit measured							

Table 27: Average result, 1000 - 6000 MHz, vertical